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WATER SUPPLY AND WATER QUALITY CONTROL STUDY. HOLLEY RESERVOIR, CALAPOOIA RIVER BASIN, OREGON

Federal Water Pollution Control Administration
Portland, Oregon

June 1967

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY

HOLLEY RESERVOIR
CALAPOOIA RIVER BASIN, OREGON

An investigation has been made which discloses a future need for storage for municipal and industrial water supply and for regulation of stream flow for water quality control in the Calapooia and Willamette River Basins, Oregon. Future water requirements and quality projections are based on economic, demographic, and engineering studies.

Prepared at the request of the District Engineer,
U. S. Army Engineer District, Portland
Corps of Engineers, Portland, Oregon

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U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration, Northwest Region
Portland, Oregon

June 1967

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I. INTRODUCTION

A. Request and Authority

The District Engineer, U. S. Army Engineer District, Portland, Oregon, in a letter dated November 1, 1963, requested the advice of the U. S. Department of Health, Education, and Welfare concerning the needs for storage for water supply and water quality control in the proposed Holley Reservoir in the Calapooia River Basin, Linn County, Oregon, and the value of benefits resulting therefrom.

The water supply portion of this study was made in accordance with the Memorandum of Agreement, dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare relative to the Water Supply Act of 1958, as amended (43 U.S.C. 390b). The water quality control aspects are considered under authority of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). Responsibility for these activities was transferred from the Department of Health, Education, and Welfare to the Department of the Interior by Re-organization Plan No. 2 of 1966, effective May 10, 1966.

B. Purpose and Scope

The investigation was conducted to advise the Corps of Engineers on the need for and value of storage in Holley Reservoir Project, Linn County, Oregon, for municipal and industrial water supply and water quality control in the Calapooia Basin and that portion of the Willamette River below the mouth of the Calapooia. To accomplish this, available data on water uses, waste sources, and water quality were examined, evaluated, and projected.

The over-all area covered by this report includes the entire drainage area of the Calapooia River and the portion of the main stem Willamette River remaining below the point it receives the Calapooia. The Calapooia and main stem Willamette portion may be discussed separately in some connections and collectively in others. The main stem Willamette portion is defined demographically by portions of Linn, Marion, Clackamas, Multnomah, and Washington Counties.

Evaluations include projected conditions to the year 2010, with an interim point at 1985. An economic base study was prepared for this purpose and is summarized in the report. The findings of the report with respect to water quality control needs are based on information contained in the FWPCA comprehensive report entitled "Water Quality Control and Management, Willamette River Basin", dated January 1967.1/

C. Acknowledgments

Information for this report was provided by officials of the communities of Brownsville and Halsey, the Oregon State Sanitary

1/ The projected water quality control flow requirements for 1985 computed for this report differ from those recommended in the FWPCA comprehensive report due to different criteria. For this report: (1) The base flow used for Portland Harbor is an expected regulated flow (storage constructed or authorized by 1965) imposed on a statistical one-in-ten year monthly distribution occurrence; and (2) An average basin-wide municipal and industrial waste treatment level of 85 percent BOD removal was used instead of the 87 percent used in the Willamette Basin report. The resultant flow requirements for 1985 are about 20 percent greater and demands on storage are about 6 percent greater.

Authority, the U. S. Soil Conservation Service, and the U. S. Army Corps of Engineers. The cooperation of these persons is gratefully acknowledged.

II. SUMMARY OF FINDINGS AND CONCLUSIONS

A. Summary of Findings

1. The site of the proposed Holley Reservoir Project is on the main stem of the Calapooia River near Holley, Oregon (drainage area 100 square miles), about 46 river miles upstream from the confluence of Calapooia and Willamette Rivers at Albany, Oregon.

2. As currently proposed by the Corps of Engineers, Holley Reservoir would have a total storage capacity of about 186,000 acre-feet. Multiple purposes to be served would be: flood control, irrigation, recreation, fish and wildlife, municipal and industrial (M&I) water supply, and water quality control.

3. Calapooia River is presently unregulated, and streamflow varies considerably from year to year and by season. The annual runoff to the river above the proposed site (28 years of record) for example, varies between 178,300 and 486,700 acre-feet and averages 324,000 acre-feet. Daily average discharges have ranged from 12,200 cfs to 13 cfs. The base flow appropriated by the Oregon State Water Resources Board for Calapooia River between Holley and its mouth at Albany is 20 cfs. At Brownsville (R. M. 32) the estimated mean minimum monthly one-in-ten year low flow, adjusted for full exercise of irrigation diversions (rights totalling 29 cfs) is 46 cfs.

4. The flow of the Willamette River is regulated for power, navigation, and flood control from existing Federal reservoirs and will be regulated additionally for these purposes upon completion of authorized storage development (total 2,161,600 acre-feet, of which about 800,000 acre-feet is being reserved for future irrigation). At the key record

station at Salem (R. M. 84), mean monthly minimum unregulated flows (3,000-3,500 cfs) will be increased to about 5,500 cfs when all existing and authorized Federal projects are in full operation. Tributary inflow below Salem contributing to flows through Portland harbor is about a minimum monthly average 1,100 cfs on a one-in-ten year low flow recurrence basis.

5. The physical and chemical quality of Calapooia River waters above the Holley Reservoir site is excellent, with the exception of sporadic sediment loads caused by high water, logging, road construction, and gravel washing. No significant sources of organic waste exist above the site. Downstream the Calapooia River has been observed to carry an organic concentration of about 0.6 mg/l five-day BOD and a coliform bacteria count ranging from 1,000 to 4,000 per 100 milliliters. During summer months, lower reaches of Calapooia River are degraded in appearance by excessive algal and other aquatic growths. Dissolved oxygen (DO) is available in minimum concentrations of greater than 7.0 mg/l. Stream temperatures greater than 70°F have been recorded near Albany.

6. The main stem Willamette River receives organic wastes equivalent to a total population of about 737,000 persons in its 120-mile length below the Calapooia River. Stream quality is progressively degraded to Portland harbor where five-day BOD concentrations commonly reach 5 mg/l and DO is reduced to as low as 2 mg/l during periods of minimum flow. Dissolved oxygen content of main stem waters above Portland harbor range above 5 mg/l and reach saturation in upper sections.

The coliform density of most sections of the river is greater than the upper limit (1,000 MPN) usually considered safe for swimming and water-contact recreation. The aesthetic quality of the river has discouraged its use as a source of municipal water supply.

7. The 1960 urban population of the over-all study area was 579,052--of which about 1,800 resided in the Calapooia Basin and adjacent Halsey area, 204,000 along study area portion of the main stem Willamette River (115 miles), and 373,628 in the Portland area. The rural population of Calapooia River Basin is about 7,000. Economic studies and forecasts for the over-all study area show a potential urban population growth to 1,090,000 and 1,990,000 by the years 1985 and 2010, respectively. Of this total, urban growth in the Calapooia Basin is expected to reach 5,500 by 1985 and 10,000 by 2010. Likewise, urban populations along the study area portion of the Willamette River above Portland will grow to 489,000 by 1985 and 986,000 by 2010.

8. Municipal and industrial water use in the Calapooia Basin and adjacent Halsey area in 1960 averaged about 160,000 gallons per day (gpd), of which 140,000 gpd was from Calapooia River at Brownsville and 20,000 gpd from groundwater at Halsey. Surface waters constitute the major source of supply and are of year-round treatable quality for this purpose. Well supplies in the Halsey area, however, are of inadequate yield and of unsatisfactory quality for domestic purposes due to high total dissolved solids content (total solids--1,200 mg/l). Municipalities in the study area portion of the main stem Willamette obtain supplies from adjacent tributary watershed areas. Portland obtains its municipal water supply from outside the Willamette Basin.

9. The only sewage collection and treatment system in Calapooia River Basin at the present time is at Brownsville. About 1,000 persons are served by this facility. Other sources of waste in the basin are a particle board plant at Brownsville, the communities of Holley and Sodaville, and miscellaneous rural centers and residences. The estimated organic load to Calapooia River from these sources is about 220 PE.

10. Major loading points along the main stem Willamette River below the Calapooia occur at Albany, Salem, Newberg, Oregon City and Portland. About 666,000 PE of waste from these sources and 70,000 PE from tributary stream sources are received in the river. More than 80 percent of the total organic load carried in the Willamette River originates as industrial waste, about one-half of which is discharged at Oregon City. The combined efficiency of waste control, particularly during low flow periods when industrial wastes are being held, barged or applied to land is about 75 percent.

B. Conclusions

1. Municipal and industrial (M&I) water demands in the Calapooia Basin portion of the study area will increase to 1.10 million gallons per day (mgd) and 2.26 mgd by the years 1985 and 2010, respectively. By the end of the study period, an annual storage need of 1,500 acre-feet in Holley Reservoir to yield about 1.3 mgd will be required to meet the 2.26 mgd demand. First need in the amount of about 500 acre-feet, will begin approximately at the time of assumed project completion (1975).

2. The annual value of storage in Holley Reservoir for M&I water supply is estimated to be $28,500 based on least-cost single-purpose alternative storage costs amortized on a 100-year basis at 3.125 percent interest and including annual O&M expenses of $3,900.

3. Beginning in about the year 1975 flow regulation in addition to adequate waste treatment will be needed in Portland harbor during the months of July, August and September to maintain dissolved oxygen (DO) levels at 5 mg/l for fish passage, fish oriented recreation and general aesthetics of the harbor. Adequate treatment or other means of controlling present and projected wastes (assuming 85 and 90 percent BOD removal by years, 1985 and 2010, respectively) along main stem Willamette above Portland harbor and Calapooia Rivers will control DO above 7 mg/l for fish rearing, spawning and other purposes without flow regulation.

4. Adequate assimilation of treated wastes in Portland Harbor by the years 1985 and 2010 will require a total minimum average seasonal flow of 8,930 and 9,280 cfs respectively during low flow periods (July through September). To obtain this flow and meet fish passage and other use objectives on a 90 percent annual achievement probability basis (one-in-ten year low flow recurrence), an annual draft-on-storage[1/] of 623,000 acre-feet by

1/ Annual draft-on-storage is the sum of incremental e cesses of needed releases over inflows during a climatic year (April through March).

1985 and 690,000 acre-feet by the year 2010 will be required. The size limitation of Holley Reservoir would permit only partial satisfaction of this requirement.

5. Quality control releases from Holley Reservoir and/or additional reservoirs, as needed, would benefit a potential population of 1,990,000 persons residing in the over-all study area. With control of DO in the harbor, annual anadromous fish migrations averaging 51,000 would be preserved, contributing therefore to continued sports and commercial fishery activities and to the economic assets associated with these and other water oriented activities.

6. Temperature enhancement in a ten-mile reach of spawning gravel can be accomplished in Calapooia River with multi-level releases from Holley Reservoir. To meet fishery requirements, flow releases from Holley Reservoir ranging from 132 cfs ($50^{o}F$) in November to 658 cfs ($70^{o}F$) in July would be required.

7. The benefits derived from flow regulation for water quality control in Portland harbor are both tangible and intangible and would accrue only after an adequate degree of waste treatment has been provided at all major waste sources. The riparian owners, downstream water users, and the populations of the surrounding area would be the major recipients of the benefits of this control. As beneficiaries are widespread throughout the Willamette Basin study area, the State of Oregon and--for the fishery use--the Pacific Northwest, the cost to provide quality

control regulation in Holley Reservoir and/or other Federal reservoirs as required would be nonreimbursable.

8. The minimum value of storage for water quality control in Willamette River Basin is considered to be at least equal to the least-cost alternative available to meet quality objectives in the absence of the project. Single-purpose storage and advanced waste treatment costs were analyzed for this purpose. Waste disposal underground, holding of waste for discharge during high flow periods, transport of wastes downstream, and restriction of future development were not considered to be adequate or equivalent alternatives.

9. Advanced waste treatment compared to least-cost, single-purpose storage (Plan A and B cost analysis prepared by the U. S. Army Corps of Engineers) was found to be the cheapest alternative to flow regulation for water quality control. The estimated annual equivalent advanced waste treatment cost per acre-foot was found to be $3.98 compared to $9.90 for single-purpose storage.

10. The minimum value of the widespread water quality control benefit assignable to an annual draft-on-storage of 690,000 acre-feet with first need for 590,000 acre-feet beginning in 1975 (assumed project completion) is $3.98 per acre-foot. Multiplied by 690,000 acre-feet...the total storage required by the year 2010...the annual benefit is $2,750,000 (rounded).

11. Specific releases from Holley Reservoir resulting in improved minimum flows in Portland harbor would be worth $3.98 per acre-foot per year on a 100-year basis. Benefits associated with releases for temperature control and flow stabilization in Calapooia River would be equal at least to the value of the enhanced anadromous fishery. This latter value will be calculated by the U. S. Fish and Wildlife Service.

12. After the project is in operation, a system of water quality and waste monitoring and streamflow forecasting will be required to effectively regulate flow for water quality control.

13. Maintenance of water quality in Calapooia River without flow regulation is predicated on the release of water which is relatively uniform in quality from Holley Reservoir. Thermal stratification and reduced dissolved oxygen in lower levels of the reservoir can be expected. Multi-gated outlets providing flexibility of releases by depth should, therefore, be considered in the design of Holley Dam.

III. PROJECT DESCRIPTION

A. Location

The proposed Holley Dam and Reservoir Project is located in the headwaters of Calapooia River, a tributary of Willamette River in northwestern Oregon. The site of the dam is about 24 air-miles and 46 river miles southeast of Albany in Linn County (see Location Map, back cover). The drainage area above the site is 105 square miles, and annual run-off averages 323,600 acre-feet.

The Calapooia River drainage basin encompasses a total area of 372 square miles. The main stem, 70 miles long, originates in the lower westerly slope of the Cascade Range and flows northwesterly to join the Willamette River at Albany. Elevations in headwater areas range up to about 4,000 feet msl.

B. Project Features

Project purposes being investigated by the Corps of Engineers include flood control, irrigation, municipal and industrial water supply, water quality control, fishery enhancement, and recreation.

As proposed by the U. S. Army Corps of Engineers, Holley Reservoir will have a total storage capacity of about 186,000 acre-feet. Space for several years of carry-over storage is included to provide supplemental water for irrigation and fishlife during extreme dry years. Principal features of the proposed dam and reservoir are:

	Elevation (Feet)	Surface Area (Acres)	Storage (Ac.-Ft.)
Dam Height	699	---	---
Maximum Pool	694	3,080	186,000
Conservation Pool	692	3,030	180,600
Flood Control Pool	660	2,110	96,000
Normal Minimum Pool	634	1,450	51,000
Streambed	530	---	---

At the maximum pool elevation Holley Reservoir would control about 30 percent of the average annual discharge of Calapooia River at Albany. A minimum sustained conservation release is planned, primarily to meet the needs of fish and wildlife.

Potential needs for storage for M&I water supply are centered in the Calapooia Basin area, at Brownsville about 13 miles below Holley and at Halsey located outside of the basin west of Brownsville. Considerations for water quality control regulation apply to the lower Calapooia River and the main stem Willamette River downstream to the mouth, including Portland harbor. Operation of the reservoir would be coordinated with existing and authorized storage development in the entire Willamette River system.

IV. STUDY AREA DESCRIPTION

A. Location and Boundaries

The study area for this report is the Calapooia River drainage basin, including the adjacent Halsey area west of Brownsville, and the portion of the main stem Willamette River below the point at which it receives the Calapooia (see Figure 1). Principal urban areas in the main stem Willamette River study area are Albany, Salem, Newberg, Oregon City, West Linn, Lake Oswego, Milwaukie and Portland.

B. Physical Features and Climate

The Calapooia River drains a narrow area between McKenzie River Basin on the south and the Santiam River Basin on the north. The upper portion of the basin area is heavily timbered. The lower portion of the basin is flat, mostly agricultural land with slopes as low as 2.5 feet per mile.

The Willamette River meanders over a broad plain northward 115 miles to its confluence with the Columbia River. At Oregon City (RM 26.6), the river drops 45 feet, forming Willamette Falls. The stream gradient of the reach above the falls (Newberg Pool) is less than 2 feet per mile. Below the falls the river flows slowly through Portland harbor and joins the Columbia River just north of the city. The river is affected by tidal movements and stage of the Columbia River from its mouth to Willamette Falls.

The climate of the study area is of the temperate maritime type, characterized by dry, moderately-warm summers and wet, mild winters. Headwaters of the Calapooia River are in one of the wettest areas of

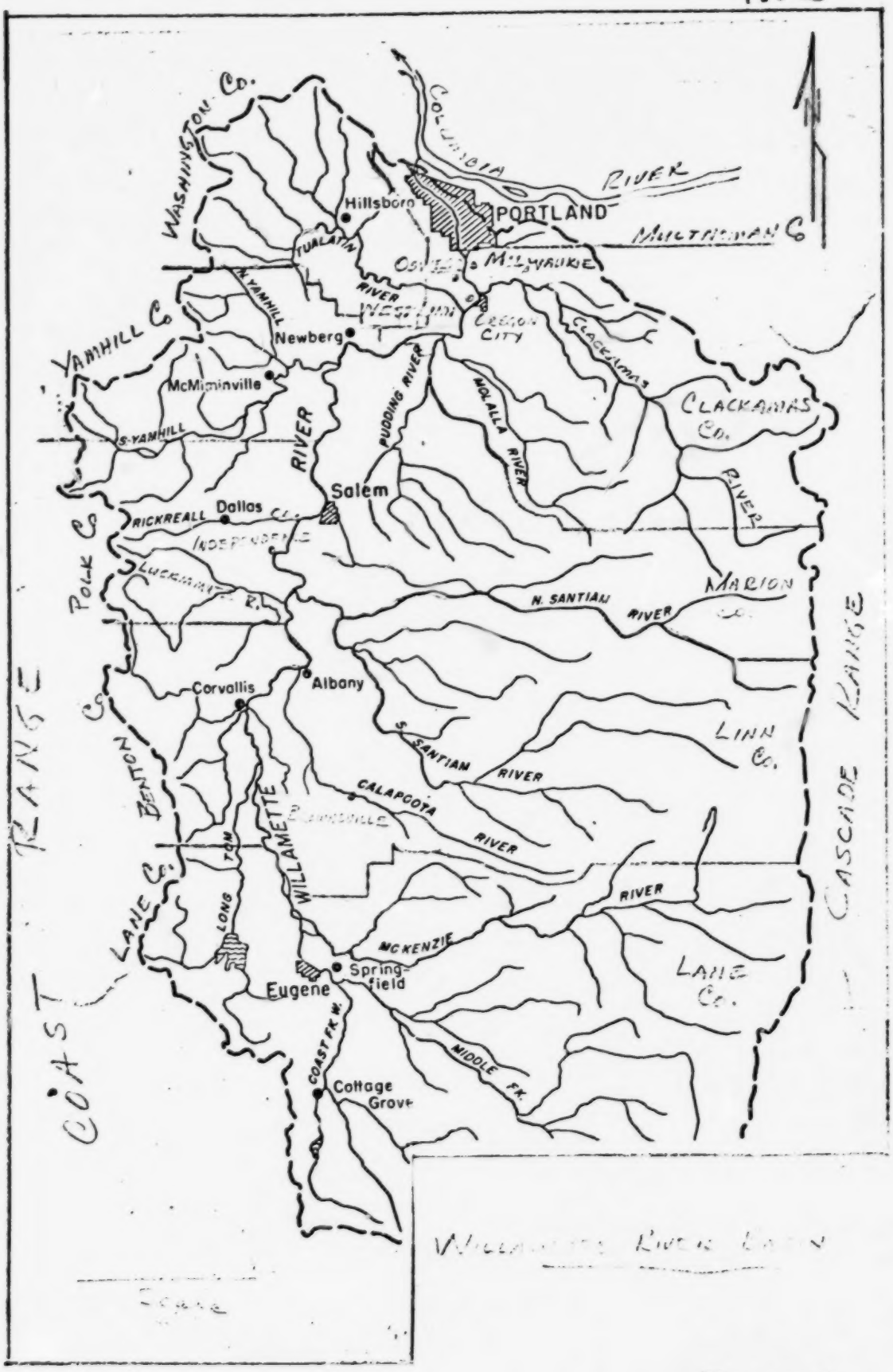

WASHINGTON CO.
COLUMBIA RIVER
Hillsboro
PORTLAND
MULTNOMAH CO.
TUALATIN RIVER
MILWAUKIE
WILLAMETTE RIVER
OREGON CITY
CLACKAMAS RIVER
YAMHILL CO.
N. YAMHILL
Newberg
McMinnville
S. YAMHILL
PUDDING RIVER
MOLALLA RIVER
CLACKAMAS CO.
Salem
RICKREALL
Dallas
POLK CO.
LUCKIAMUTE R.
N. SANTIAM RIVER
MARION CO.
Corvallis
Albany
S. SANTIAM RIVER
LINN CO.
BENTON CO.
CALAPOOYA RIVER
LONG TOM
WILLAMETTE R.
MCKENZIE RIVER
LANE CO.
Eugene
Spring-field
COAST FK. W.
MIDDLE FK.
Cottage Grove
COAST RANGE
CASCADE RANGE

FIGURE 1

the Willamette River Basin. Although the normal annual precipitation at the Holley Dam site is about 56 inches, that of the headwaters region exceeds 110 inches. The normal annual precipitation for the watershed is approximately 80 inches. The temperatures of the basin are moderate except for occasional short periods of hot or cold weather. The temperature extremes at Albany, near the mouth of the Calapooia River, have ranged from 104 to minus 15° F. Growing season in the agricultural areas varies from 180 to 200 days.

V. WATER RESOURCES OF THE STUDY AREA

A. Calapooia Basin Portion of the Study Area

1. Surface Water

a. Existing Water Resources Development

Water resources development in the Calapooia Basin is closely related to land utilization. In general, land use upstream from Holley is almost exclusively devoted to forestry, while a considerable portion of the downstream area of the Calapooia Basin has been developed for agriculture. No major storage reservoirs have been constructed in Calapooia Basin.

Basin lands have been irrigated since about 1905. The Calapooia River is an adjudicated stream serving over 100 individual water rights for the irrigation of approximately 2,700 acres. These rights total about 31 cfs. Brownsville has a surface water right of 0.67 cfs for municipal purposes.

A basin-wide irrigation plan has been developed by the U. S. Bureau of Reclamation which would provide a water supply for 41,700 irrigable acres. This is considered to be the ultimate irrigation development potential within the Calapooia Basin. Most of this area lies north of the reach of the river downstream from Brownsville.

b. Hydrology and Stream Flow Frequency Analysis

Stream flows have been recorded for the Calapooia River at Holley since 1935 and at Albany since 1940 (see Figure 2, Schematic Diagram). A summary of these data is included in the appendix (Table 1).

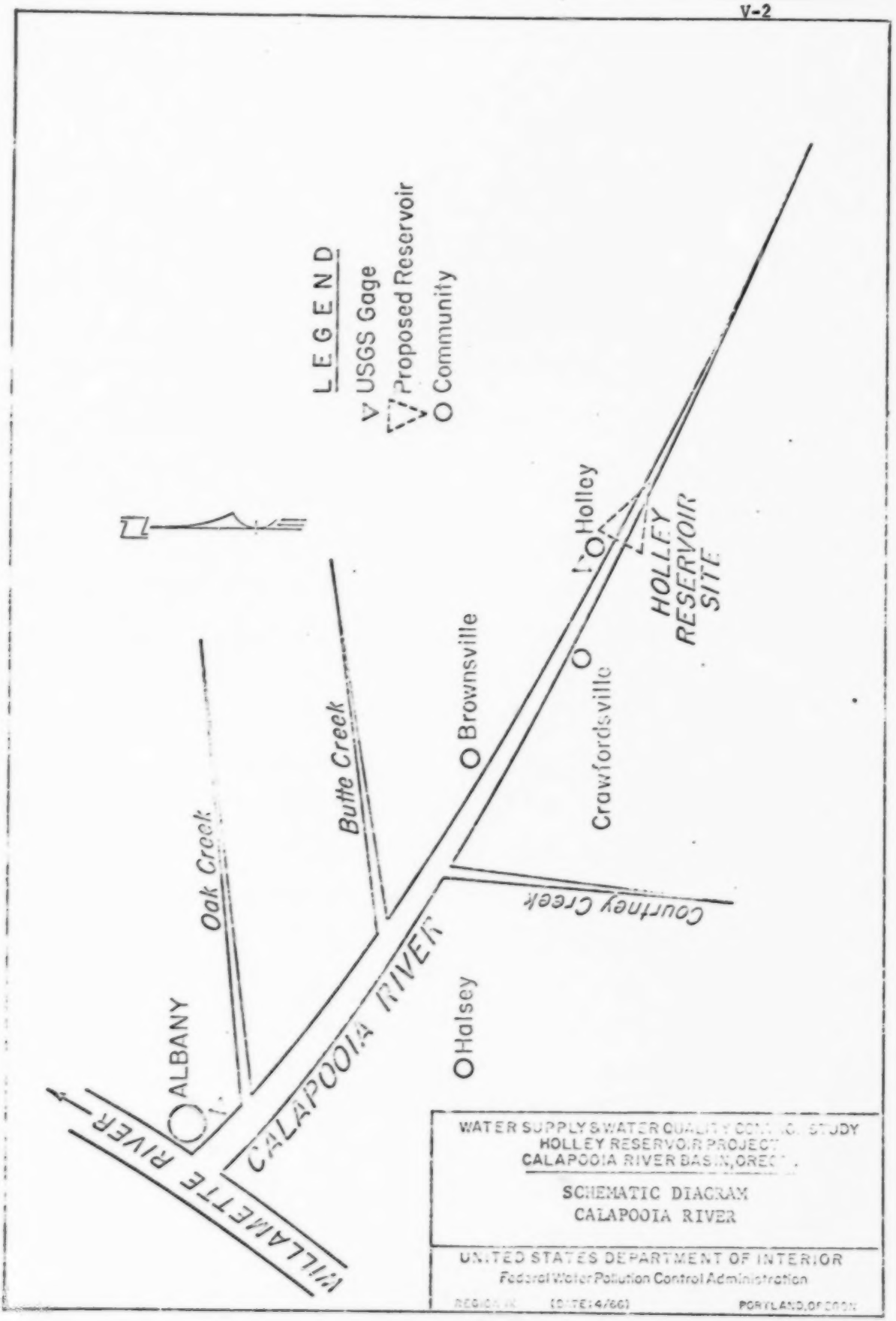

LEGEND
USGS Gage
Proposed Reservoir
Community
Holley
HOLLEY RESERVOIR SITE
Brownsville
Crawfordsville
Butte Creek
Oak Creek
Courtney Creek
CALAPOOIA RIVER
Halsey
ALBANY
WILLAMETTE RIVER
WATER SUPPLY & WATER QUALITY CONTROL STUDY
HOLLEY RESERVOIR PROJECT
CALAPOOIA RIVER BASIN, OREGON
SCHEMATIC DIAGRAM
CALAPOOIA RIVER
UNITED STATES DEPARTMENT OF INTERIOR
Federal Water Pollution Control Administration
REGION IX
DATE: 4/66
PORTLAND, OREGON

FIGURE 2

A low-flow frequency analysis was performed using the mean annual flows of record at Holley and Albany for the twenty-three years from 1941 to 1963, inclusive. A distribution of mean monthly low flow with recurrence intervals of 5, 10, and 20 years was developed. The natural mean monthly low flow of the river at Brownsville, with a recurrence frequency of one-in-ten years, adjusted for full exercise of irrigation diversion rights is estimated to be approximately 46 cfs.

c. Water Quality

The physical and chemical quality of water above the proposed reservoir is considered excellent, although at times sediment concentrations reach significant proportions. In 1949-50, the Calapooia River discharged an estimated sediment load of 90,340 tons per year at Albany (7). Activities such as logging, road construction, and gravel washing occasionally contribute substantial sediment loads to the stream and are suspected of causing damage to fish spawning and propagation. Under impounded conditions, changes in water quality will occur. These changes in quality are discussed in Chapter VIII, Water Quality Control.

The main stem Calapooia River below Brownsville is a low gradient, sluggish stream and contributes to temperature and nutrient enrichment conditions conducive to excessive growths of algae and other aquatic forms.

Analytical results of stream samples collected at Albany are shown in Table 5 of the Appendix. Organic matter in terms of biochemical oxygen demand (BOD) is normally less than 1 mg/l at Albany, and dissolved oxygen has generally been greater than 7 mg/l (80 percent of saturation) during relatively low-flow periods (20-40 cfs).

2. Groundwater

a. Quantity

Groundwater in the Calapooia River Basin is an important complement to the surface water resources of the area. Most of the rural domestic water needs are supplied by groundwater. The greatest use of groundwater in Calapooia Basin is for irrigation. Irrigation rights totalling about 16 cfs presently exist.

Groundwater is relatively abundant in the basin due in large part to the occurrence of coarse, permeable, and relatively silt-free alluvium derived from the volcanic rocks of the Cascade Range. Yield capability of wells in the area east of Brownsville is lowest, while in the western part of the basin wells generally yield up to several hundred gallons per minute (gpm). The highest yields (up to 1,000 gpm) are obtained from wells located along the main stem in its lower reaches and along Oak Creek.

b. Quality

Groundwater quality in the Calapooia Basin is generally suitable for both domestic and irrigation uses. Many wells, however, are shallow and receive surface seepage, thereby being susceptible to pollution. Serious quality problems exist in certain areas of the lower basin where mineral contamination and surface pollution of groundwater restrict use and necessitate treatment. Wells drilled deeper than 100 feet often tap water with sufficient salt content to be unfit for domestic or irrigation use. Hardness is also a problem. This is readily apparent by comparison of data presented in Table 6 of the Appendix.

B. Willamette River Portion of the Study Area

1. Existing and Planned Water Resource Development

The present water resource development in the Willamette Basin has evolved over the last three decades as a result of continuous study of the flood control power, navigation, and related resource needs. Initially authorized by the Flood Control Act of 1938 and repeatedly modified by subsequent acts, this development provides a system of multi-purpose reservoirs which regulate the flows of the Willamette and its tributaries.

At present, there are fourteen multi-purpose storage reservoirs authorized in the Willamette Basin. Eight of the fourteen are in operation; together with three power reservoirs, these provide a usable storage capacity of 1,515,600 acre-feet. Reservoirs under construction will provide an additional 646,000 acre-feet of usable storage. Existing and authorized storage capacity of 2,161,600 acre-feet is about 8.3 percent of the annual 26 million acre-feet runoff of the basin.

The U. S. Army Corps of Engineers estimates a potential 1,100,000 acre-feet of additional storage in the Willamette system, which would bring the total storage capacity to 12.5 percent of the annual runoff. Investigations by FWPCA for the Bureau of Reclamation on proposed irrigation projects on the Tualatin and Yamhill Rivers and Rickreall Creek revealed that benefits would accrue from provision for storage for water quality control and municipal and industrial water supply. Storage in earlier reservoirs was not allocated for these specific uses.

When all existing and authorized Federal reservoirs are in full operation in Willamette Basin, the minimum unregulated mean monthly low flow at Salem (about 3000 cfs) will have been increased to approximately 5,500 cfs and in Portland harbor to about 6,500 cfs.

2. Stream Flow Frequency Analysis

Stream flows have been recorded for the lower Willamette River at Salem since 1909 and flow estimates of lower reaches are customarily referenced to this gage (see Figure 3). Table 4 in the Appendix shows the results for a frequency analysis of stream flow at Salem and Portland harbor. The lowest mean monthly flow of the Willamette River at Salem and at Portland--adjusted for regulation by all reservoirs now in operation, under construction, or authorized--is estimated to be approximately 3,660 cfs and 4,760 cfs, respectively, on a recurrence frequency of one-in-ten years.

3. Water Quality

The chemical and physical quality of the main stem Willamette River downstream to Newberg pool, a rather sluggish reach formed behind Willamette Falls, is suitable for most uses. Hardness ranges generally from 15-25 mg/1 and dissolved solids from about 50 to 100 mg/1. Nutrient concentrations as nitrate have shown an increase between Albany and Newberg from about 0.25 mg/1 to 0.5 mg/1. Maximum water temperatures are in the order of 70° F during summer months. During these times below Newberg pool (Portland harbor), stream waters are drastically degraded, as evidenced by increased biochemical oxygen demand and critically low dissolved oxygen content. Figures 4 and 5 illustrate these conditions. As noted, dissolved oxygen has on occasion dropped to about 2 mg/1.

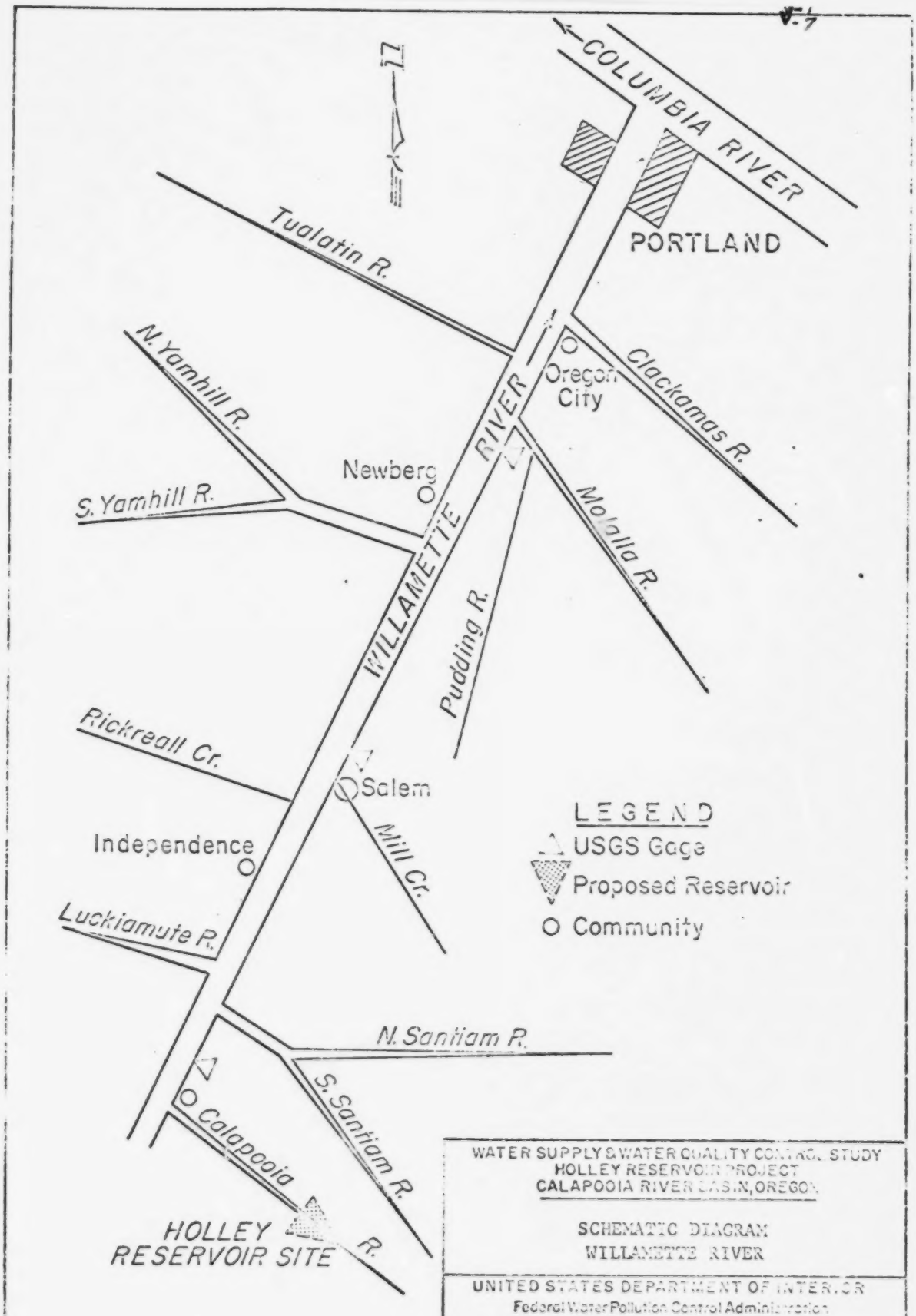
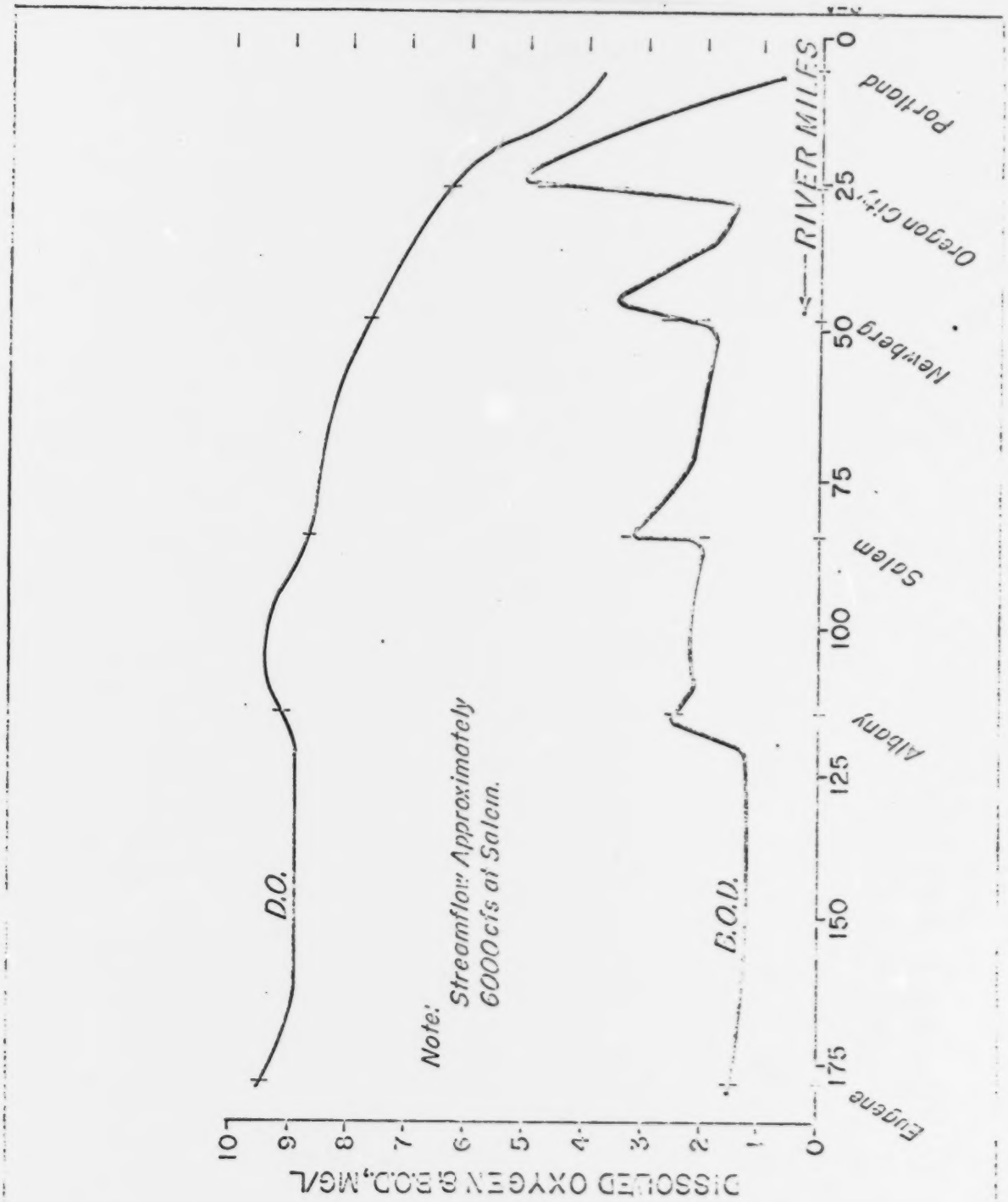

COLUMBIA RIVER
PORTLAND
Tualatin R.
N. Yamhill R.
Oregon City
Clackamas R.
Newberg
S. Yamhill R.
WILLAMETTE RIVER
Molalla R.
Pudding R.
Rickreall Cr.
Salem
Mill Cr.
Independence
Luckiamute R.
N. Santiam R.
S. Santiam R.
Calapooia R.
HOLLEY RESERVOIR SITE
LEGEND
USGS Gage
Proposed Reservoir
Community
WATER SUPPLY & WATER QUALITY CONTROL STUDY
HOLLEY RESERVOIR PROJECT
CALAPOOIA RIVER BASIN, OREGON
SCHEMATIC DIAGRAM
WILLAMETTE RIVER
UNITED STATES DEPARTMENT OF INTERIOR
Federal Water Pollution Control Administration
REGION IX
PORTLAND, OREGON

FIGURE 3



WATER SUPPLY & WATER QUALITY CONTROL STUDY
HOLLEY RESERVOIR PROJECT
CALAPOOIA RIVER BASIN, OREGON

DISSOLVED OXYGEN & BOD
WILLAMETTE RIVER

UNITED STATES DEPARTMENT OF INTERIOR
Federal Water Pollution Control Administration

REGION IX (DATE: 4/68) PORTLAND

WATER SUPPLY & WATER QUALITY CONTROL STUDY
HOLLEY RESERVOIR PROJECT
CALAPOOIA RIVER BASIN, OREGON

DISSOLVED OXYGEN & TEMPERATURE
LOWER WILLAMETTE RIVER

UNITED STATES DEPARTMENT OF INTERIOR
Federal Water Pollution Control Administration

REGION IX (DATE: 4/66) PORTLAND, OREGON

FIGURE 5

VI. THE ECONOMY

A. General

The demand for water for municipal and industrial purposes, and the amount and character of waste waters resulting from such uses, are determined largely by the activities associated with a region's economic base. The purpose of this section is to present economic and demographic data to be used as a basis for projecting the needs for water for municipal and industrial purposes and for estimating the future amounts and types of waste and land drainage material that may be expected to occur in the Calapooia and main stem Willamette River study area with the expanded development anticipated in the future.

B. Present

The economic growth of the Calapooia and main stem Willamette study areas has historically been based on timber and agriculture. Although diversification has taken place in recent years, these two natural resource related industries continue to provide the impetus for overall growth and development. Timber harvesting and lumber production reached peak levels between 1943 and 1956. Since 1956, there has been a sharp decline in lumber production, although the plywood and wood fiber industries have continued to expand.

Lumber and wood-products manufacturing are presently the largest industries in the Calapooia River Basin. Economic activity centers around Brownsville, the basin's largest community, where several sawmills (employing about 125 persons) and a small particle board plant are the major employers.

There has been some decrease in total farm acreage during the past 30 years, but an increase in crop-land acreage. Most of this increase has been in vegetables, with a decrease in small grains, tree fruits, and nuts. The foremost crop in the area is seed grass. A seed warehouse in Halsey is one of the largest in the Willamette Basin and is the town's principal employer.

The Calapooia Basin reflects the national trend toward a decrease in rural population. At the present time, however, the majority of people continue to live on farm sites. Total population in the Calapooia River Basin in 1960 was 8,800.

The Willamette main stem urban areas below Calapooia River serve as trade and service centers, several of which have attracted many diversified industries along with lumber and wood-products. The Portland Metropolitan Area provides a trading and service center for many Willamette and State of Oregon communities and industries. Pulp and paper mills are located at Oregon City, West Linn, and Newberg. Food processing plants operate on a seasonal basis at Albany and Salem.

Table VI-1 shows the 1950 and 1960 population of incorporated towns in the Calapooia Basin and main stem Willamette River study areas.

C. Projected Economic Base and Population

1. Factors Influencing Future Growth

The economic future of the Calapooia Basin to year 2010 will most likely follow existing trends. Some increase in the timber harvest due to maturing of second-growth stands may be expected and, with the

TABLE VI-1
POPULATION OF INCORPORATED PLACES
WILLAMETTE RIVER MAINSTEM & CALAPOOIA RIVER BASIN

Location	1950	1960
WILLAMETTE RIVER MAINSTEM:		
Portland	373,628	372,298
Milwaukie	5,253	9,099
Oswego	3,316	8,906
Gladstone	2,434	3,854
West Linn	2,945	3,933
Oregon City	7,682	7,996
Newberg	3,946	4,204
Salem	43,140	49,142
Independence	1,987	1,930
Albany	10,115	12,926
CALAPOOIA RIVER BASIN:		
Brownsville	1,175	875
Halsey	388	404
Sodaville	157	145

Source: U. S. Census of Population, 1950 & 1960.

expansion of this resource, the basin's forest-products industries will grow. Capacity at the sawmill in Brownsville should increase, and increased capacity at the particle board plant also seems likely. Agricultural production is expected to increase due to expanded irrigation and improved productivity. With increased irrigation, a more diversified agricultural base, with greater emphasis on dairying and vegetable crops could logically develop. This will provide the resource for an increased service industry at Brownsville and Halsey. Some spill-over of the growth anticipated for urban areas of Linn (particularly Albany) and Lane Counties may add to the basin's growth. Development of a substantial manufacturing industry appears unlikely.

In the lower Willamette Basin it is expected that the ratio of service industry jobs to manufacturing jobs will increase in line with national trends. Service industry categories whose employment increased most rapidly during 1950-60 will probably continue to show the greatest increases in the future. These include truck transportation and warehousing, wholesale trade, finance-insurance-real estate, professional services, education, and public administration.

In manufacturing, continued growth of population is expected to make possible the establishment of market-oriented plants for the production of goods formerly brought in from outside the Portland region. Except for those industries whose location is oriented towards the site of a fixed resource, it is expected that the distribution of employment in the region will become more like that in the nation. On this basis, growth is particularly likely to occur in the following

categories: machinery, vehicles and other transportation equipment, shipbuilding, cement, glass, concrete, stone and clay products, professional and photographic equipment, textiles, apparel, and chemicals.

2. Future

The Holley Reservoir project and its possible influence on irrigation is the principal modifying factor to be considered in gaging the future of the Calapooia Basin. If the history of other irrigation developments may be used to interpret probable effects in the basin, additional irrigation can be expected to slow the downward course of population trends. Large agricultural outputs are more likely to result in expansion of food-processing activities in the Salem or Albany service area than in establishment of processing in the Calapooia River Basin.

The proposed Holley Reservoir project anticipates eventual service to 41,700 acres of new land in Calapooia Basin. The servicing of organized districts is expected to be gradual with full service in about 30 years.

In the past few years, a leveling off in production of timber products has been experienced within the middle Willamette Basin (from the Long Tom to the Tualatin). It is probable that a plateau has been reached and will continue during the next 20 years. Timber lands should be near sustained-yield levels at about the end of the study period.

Neither the recent history of the Calapooia Basin area nor the prospects of economic development outlined above suggests vigorous population expansion during the study period. Most of the growth in the

basin is forecast to occur at Brownsville. While rural population if forecast to remain about 7,000, it is anticipated that the present Brownsville population will triple by 1985 and that the 2010 population will be double that of 1985. The other incorporated places in the basin will increase slightly but not significantly. Table VI-2 shows the projected population for the Calapooia Basin.

TABLE VI-2
PRESENT AND PROJECTED POPULATION
CALAPOOIA RIVER BASIN, OREGON
1960, 1985, & 2010

Location	Population, in thousands		
	1960	1985	2010
Brownsville.	1.0	3	6
Halsey	0.4	1	2
Holley-Crawfordsville.	0.2	1	1
Sodaville.	0.2	0.5	1
Rural Area	7.0	7	7
TOTAL, Calapooia River Basin . . .	8.8	12.5	17

Future Willamette main stem population growth was estimated from projections of future employment in manufacturing industries, together with assumptions concerning ratios of service-to-manufacturing employment and ratios of population-to-total labor force. As a check, the results obtained were compared with national population projections allocated to various states and hence, to river basin areas in Oregon. The results of these population forecasts are summarized in Table VI-3.

TABLE VI-3
PRESENT AND PROJECTED POPULATION
WILLAMETTE RIVER MAIN STEM, OREGON
1960, 1985, & 2010

Tributary Area	Population, in thousands		
	1960	1985	2010
Portland (City Limits)	373	600	1,000
Milwaukie & Vicinity	38	107	220
Oswego & Vicinity	14	40	80
Gladstone & Vicinity	7	16	35
West Linn	4	11	21
Oregon City & Vicinity	11	26	48
Newberg	6	17	38
Salem	77	178	363
Albany	15	41	91
Other	32	53	90
TOTAL	577	1,089	1,986

VII. WATER REQUIREMENTS--MUNICIPAL AND INDUSTRIAL

A. Present Water Use

Communities within direct range of the proposed Holley Reservoir are Holley, Brownsville and Halsey. Depending upon the quantity and quality of water available at each location, these communities' water supplies could benefit from storage.

The City of Albany, located at the mouth of the Calapooia River, obtains its water supply from the South Santiam River outside of the study area. Holley, Sodaville, and other small communities within Calapooia Basin have not yet developed community water supply systems. Residents of these smaller communities, as well as people living in rural areas, are supplied by wells and other individual facilities.

The Brownsville municipal water facilities serve approximately 1,000 persons at the average rate of 140,000 gallons per day (gpd), or 155 acre-feet per year. Water is obtained from an infiltration gallery on the Calapooia River. The water plant has a rated capacity of 720,000 gpd (1.1 cfs). Brownsville has surface and groundwater rights of 430,000 and 320,000 gpd, respectively.

At Halsey, the Citizens Water and Light Company provides water from a well to serve approximately 200 persons at the average rate of 20,000 gpd, or 22 acre-feet per year.

No significant amount of surface or ground water is being used exclusively for industrial purposes in the Calapooia Basin.

B. Existing Source Development

The greatest demand for M&I water in the Calapooia Basin occurs at Brownsville. The minimum daily flow recorded for the Calapooia River at Brownsville is approximately 13 cfs (8.4 mgd). This flow would also be available to the Holley community, located about 13 miles upstream. Chemical analyses indicate a relatively good quality water at Brownsville (see Table 6, Appendix). Chlorination is the only treatment practiced.

The municipal well at Halsey has a rated capacity of 50 gpm. The present demand averages about 20,000 gpd, or 14 gpm. Difficulties have been experienced in developing well supplies in this area due to limited yields and water quality is generally unsatisfactory due to high brine content (see Table 6, Appendix).

C. Forecast of Future Water Needs

Projected population growth in the Calapooia area (Table VI-2) and increasing per capita water demands indicate increased requirements for M&I water within the study period to year 2010. Based on trends toward higher per capita demands in the whole Willamette Basin, the estimated daily per capita demand by 1985 will be about 200 gallons and by 2010 about 225 gallons. Applying these values to expected municipal populations in the Calapooia area reveals future demands as shown in Table VII-1. The expected annual demand distribution for Brownsville, the major supply in the basin, is shown in Table VII-2.

TABLE VII-1
MUNICIPAL AND INDUSTRIAL WATER DEMAND
CALAPOOIA RIVER BASIN, OREGON
1960, 1985, & 2010

Community	Year	Population Served (1000's)	Ave. Annual Demand (mgd)	Maximum Demand Monthly (mgd)	Maximum Demand Daily (mgd)
Brownsville	1960	1	0.14	0.26	0.4
	1985	3	0.60	1.1	1.6
	2010	6	1.35	2.6	3.6
Halsey	1960	0.2	0.02	0.04	0.06
	1985	1	0.20	0.4	0.5
	2010	2	0.45	0.8	1.2
Holley	1960	0	0.00	0.0	0.0
	1985	1	0.20	0.4	0.5
	2010	1	0.23	0.4	0.6
Sodaville	1960	0	0.00	0.0	0.0
	1985	0.5	0.10	0.2	0.3
	2010	1	0.23	0.4	0.6

TABLE VII-2
PROJECTED AVERAGE MONTHLY M&I WATER DEMAND AT BROWNSVILLE
CALAPOOIA RIVER BASIN, OREGON
1985 & 2010

Month	1985 Percent of Avg. Annual Demand	1985 Demand (mgd)	2010 Percent of Avg. Annual Demand	2010 Demand (mgd)
January	70	0.42	68	0.92
February. . . .	68	0.41	72	0.96
March	69	0.41	74	0.99
April	75	0.45	79	1.06
May	105	0.63	83	1.11
June.	166	1.00	132	1.76
July.	191	1.15	195	2.62
August.	138	0.83	158	2.11
September . . .	89	0.53	106	1.42
October	79	0.47	86	1.15
November. . . .	76	0.46	76	1.04
December. . . .	74	0.44	71	1.06
AVERAGE	100	0.60	100	1.35

Study area water demands for the respective years 1985 and 2010 are projected to total 1.10 and 2.26 mgd. Demands in areas within range of Holley Reservoir for these years are 1.0 and 2.03 mgd, respectively. About 65 percent of this demand will occur at Brownsville.

Limits on waters presently available in Calapooia Basin and adjacent areas indicate a relatively early need for storage to supplement existing municipal rights in the Brownsville and Holley areas and to replace groundwater supplies at Halsey. The annual need by the end of the study period is for about 1,500 acre-feet of storage to yield 1.3 mgd. First need for about 500 acre-feet will begin at the time of assumed project completion (1975) when summer demands are expected to exceed water rights and when transmission and treatment facilities at Halsey could be completed for operation.

VIII. WATER QUALITY CONTROL

A. Need for Control

Surface waters in the Calapooia and Willamette River Basins are used for municipal and industrial water supply, resident and anadromous fishery, recreation, navigation, irrigation, power and disposal of municipal and industrial waste.

1. Municipal and Industrial

As discussed in the preceding chapter, both the existing and potential supplies in Calapooia Basin rely heavily on surface water. No use is made of Willamette River below the mouth of Calapooia River for M&I supply; and no appreciable use is expected within the period of this study.

2. Fishery

One of the outstanding uses of the Willamette River and its tributaries is the production of anadromous fish for the sport and commercial fisheries of the Willamette and Columbia Rivers and the Pacific Ocean. Large populations of salmon and steelhead, highly prized by sport anglers and commercial fishermen alike, make the Willamette fishery of unique importance. It should also be noted that the Willamette is a "nursery," providing many of the fish for the commercial fishery in the ocean and the Columbia River. Moreover, the abundance of fast-moving, sparkling clear streams in the headwater areas provides an excellent habitat for the delicate salmonid species and an abundance of fishing opportunities to the sportsman.

Game and food fish found in the Willamette Basin are the anadromous salmon (spring chinook, fall chinook, and coho), steelhead trout, resident species of trout, and warm-water game fish. Sturgeon and shad are also present downstream from Willamette Falls.

An inventory of spring chinook in the Willamette River is available from counts made annually at Willamette Falls by the State Fish Commission and from the annual sport fishery survey made jointly by the State Fish and Game Commissions. The average annual run into the Willamette during the period 1946-1964 was 51,000 fish. The average escapement upstream past Willamette Falls was 36,100 fish, with an additional 2,500 fish entering the Clackamas River. The difference between the run and escapement (12,000 fish) is the sport catch. Accurate estimates of coho and steelhead are not available, but their numbers are not large at the present time.

Enhancement of the Calapooia and main stem Willamette fishery is believed possible with improved passage facilities, controlled water quality and increased minimum stream flows. Potential fish runs possible under controlled conditions are estimated as follows: spring chinook--65,000, fall chinook--90,000, coho--90,000, steelhead--40,000. The Bureau of Commercial Fisheries estimates the gross value of these fish to be nearly $4 million annually, three-fourths of which is attributable to commercial fishing.

3. Recreation and Aesthetics

Recreation development has been largely concentrated near headwater areas, distant from population centers of the valley. However, if the current trends of increased income and leisure time continue, there will be growing pressure for broader recreational use of the Willamette River itself, which is the water recreational resource nearest the basin's populations. There are riverside park developments in most of the communities along the banks of the Willamette; most have boat launching facilities; and each has supported measures to improve the quality of local waters through waste treatment. Current plans of Willamette Basin communities include expansion of river parks at Eugene, Corvallis, Albany, Salem, and Portland.

The Willamette River passes by, or through, every major community in the basin. More than a million persons, two-thirds of Oregon's population, lived in the Willamette Basin in 1960, and over half of these in a dozen communities on the banks of the Willamette. The use of water for recreation and as a scenic adjunct to dwelling sites is a significant manifestation of public appreciation of attractive waterbodies. As in development of recreational facilities, there is a trend toward more complete utilization of the river in community environment. The beauty of the physical environment is being recognized locally and nationally as important to community feeling, productivity and personal satisfaction.

4. Irrigation

In 1964, about 200,000 acres were being irrigated in Willamette Basin; by 1985, irrigated land is projected to be about 350,000 acres;

and by 2010, irrigated land may be as high as 750,000 acres. Based on the 1964 crop distribution, the gross water diverted for irrigation was 2.56 acre-feet per acre. Applying this factor, the total water diverted for irrigation in the Willamette Basin may be estimated as follows: 1960--512,000 acre-feet; 1985--896,000 acre-feet; and 2010--1,920,000 acre-feet. The impact of irrigation water return flows is not expected to be significant in most areas of the basin.

B. Municipal, Industrial, and Agricultural Pollution

Present and potential municipal and industrial waste discharges to main stem Calapooia and Willamette Rivers are major considerations in establishing needs for flow regulation for water quality control in the proposed Calapooia River Project. Water pollution measured in terms of organic waste demands on the dissolved oxygen (DO) resource of stream waters and DO requirements for maintenance of an adequate environment for fish and other aquatic life dictate the level of control required. As indicated in Chapter V, Portland harbor is the only section along the main stem Willamette River where significant DO depletions have occurred and where a need for greater control of water quality is indicated.

Agricultural pollution in Willamette Basin is recognized mainly as a bacteriological problem, reducible by restrictions on animal feed lots and grazing areas. Control of bacterial pollution by flow regulation is neither practical nor effective. Irrigation return flows, although minimal, carry soil minerals, fertilizers, pesticides, etc. to surface streams.

1. Present Waste Loads

In Calapooia Basin, the community of Brownsville is the largest single source of municipal and industrial waste. Municipal waste in this area is collected and treated by lagoon stabilization. The total daily load to Calapooia River in this area, including industrial particle board plant waste, is estimated to be 220 PE.

Major loading points along the Willamette River study area exist at Albany, Salem, Newberg, Oregon City and Portland. Tributary streams contributing residual loadings to main stem Willamette are Luckiamute and Santiam Rivers, Rickreall Creek and Yamhill, Molalla, Tualatin and Clackamas Rivers. Table VIII-1 summarizes for 1964 the direct and indirect or residual loads (total of 737,000 PE) received in the Willamette River downstream from the Calapooia River. An inventory of major waste sources in the entire Willamette Basin is given in Table 9 of the Appendix.

Of the total waste produced in 1964, approximately 18 percent was derived from municipal sources and approximately 82 percent from industries. Pulp and paper mills located throughout the basin contribute a substantial portion (81%) of the total industrial load. Food processing plants add another 15 percent, and the balance is produced by a diversity of manufacturing and service industries.

2. Future Waste Loads

Future waste load projections are based on the economic forecasts presented in Chapter VI. Tables VIII-1 and -2 respectively,

TABLE VIII-1
PRESENT AND PROJECTED M&I WASTE LOADS
WILLAMETTE RIVER MAINSTEM, OREGON

Service Area	Population Equivalents (PE) 1964	1985	2010
Willamette River			
Residual @ Albany	57,000	147,000	214,000
Albany			
Municipal	2,400	7,680	11,100
Industrial	27,290	40,460	48,040
Total	29,690	48,140	59,140
Luckiamute River			
Total Residual	1,700	1,700	1,700
Santiam River			
Total Residual	49,000	77,000	60,500
Independence			
Municipal	1,020	2,810	4,000
Industrial	90	140	120
Total	1,110	2,950	4,120
Rickreall Creek			
Total Residual	500	500	500
Salem			
Municipal	12,730	33,450	45,300
Industrial	169,800	338,850	396,900
Total	182,530	372,300	442,200
Yamhill River			
Total Residual	2,600	5,200	5,400
Newberg			
Municipal	670	3,200	4,750
Industrial	116,330	246,820	275,100
Total	117,000	250,020	279,850
Molalla River			
Total Residual	1,900	3,800	4,200
Canby			
Municipal	360	1,310	1,750
Tualatin River			
Total Residual	3,100	11,600	16,000

(continued, next page)

TABLE VIII-1 (continued)
PRESENT AND PROJECTED M&I WASTE LOADS
WILLAMETTE RIVER MAINSTEM, OREGON

Service Area	Population Equivalents (PE) 1964	1985	2010
Oregon City			
Municipal	2,930	13,050	17,320
Industrial	309,000	375,900	275,200
Total	311,930	388,950	292,520
Clackamas River			
Total Residual	11,800	11,800	11,800
Portland Urban Area[1/]			
Municipal	4,650	25,200	34,200
Industrial	19,200	0	0
Total	23,850	25,200	34,200
SERVICE AREA TOTALS			
Municipal	24,760	86,700	118,420
Industrial	641,710	1,002,170	995,360
SUBTOTAL	666,470	1,088,870	1,113,780
TRIBUTARIES	127,600	258,600	314,100
GRAND TOTAL	794,070	1,347,470	1,427,880

[1/] Major portion treated and discharged to Columbia River

TABLE VIII-2
PROJECTED M&I WASTE LOADS
CALAPOOIA RIVER, OREGON

Service Area	Population Equivalents (PE) 1985	2010
Holley-Crawfordsville[1/]	200	200
Brownsville	600	1,100
TOTALS	800	1,300

[1/] Assumed installation of collection and treatment facilities by 1985.

show the combined municipal and industrial loading expected along the Willamette and Calapooia Rivers for the years 1985 and 2010. The loadings shown assume provisions for adequate treatment conforming with the Federal Water Pollution Control Act (33 U.S.C. 466 et seq.), which provides that the inclusion of storage for regulation of streamflow for the purpose of water quality control shall not be provided as a substitute for adequate treatment or other means of controlling waste at the sources.

Adequate treatment is considered by the Federal Water Pollution Control Administration to mean effective waste collection and secondary treatment for domestic wastes and equivalent reduction of industrial waste loads by a combination of process control, internal waste savings, water reuse and effluent treatment. At the present time, efficiently operated trickling filter plants, widely used in intermediate sized communities, are considered capable of 80 to 90 percent BOD removal while the activated sludge process is considered capable of 85 to 95 percent removal. Because of the problems of efficient operation to maintain such high removals, the effect of diurnal fluctuations in waste loads, the lags experienced in plant construction to provide for the growth in waste loads, and the uncollectible wastes associated with urban storm water and/or combined sewer overflows, it is deemed reasonable at this time to expect an overall equivalent of 85 percent BOD removal in a well operated sewage collection and treatment system. In this study area,

where the largest waste loads are from the pulp and paper industry and where barging, lagooning and land disposal of waste is practiced, it is believed that BOD reductions of 85 and 90 percent with respect to the stream are feasible for the years 1985 and 2010, respectively, and have been used for design purposes in this report.

C. Water Quality Objectives

Water quality control evaluations consider primarily those water quality and pollution control problems which can be improved or maintained by streamflow regulation. For the Calapooia and Willamette Rivers these include dissolved oxygen, temperature, and nuisance aquatic growths, and are associated with maintenance of fish life, water recreation, and aesthetic environment. Water quality objectives have been developed for the various uses based on the following indicators.

1. Dissolved Oxygen

The dissolved oxygen (DO) objective for Calapooia and Willamette Rivers is delimited by anadromous fishery requirements--the use requiring the highest DO level. Other uses served at this level are recreation and aesthetic conditions.

Calapooia River above Butte Creek (R.M. 19.8) provides spawning and rearing habitat for salmon and steelhead requiring DO levels of no less than 7 mg/l. Below Butte Creek, the Calapooia River is sluggish and unsuited for fish spawning and rearing, thus this reach requires a minimum DO objective of 5 mg/l to assure satisfactory fish passage.

Since the Willamette River main stem above Oregon City is used at all times of the year for salmon and steelhead spawning, rearing and migration, a minimum DO objective of no less than 7 mg/l must be maintained throughout the year. Below Willamette Falls at Oregon City, and through Portland harbor, a minimum of 5 mg/l is required to assure adequate fish passage.

2. Temperature

Temperature requirements for the Calapooia and Willamette Rivers are governed mainly by the anadromous fishery. Recreation and general stream conditions also benefit from cooler water temperatures. Maximum temperatures should not exceed 70°F during summer months to facilitate fish migration, holding and rearing, and by mid-September, temperatures should not exceed 57°F to obtain optimum egg survival.

Maintenance of optimum temperature and DO levels by selected releases from storage at the Holley site would be expected to enhance the anadromous fish habitat, particularly in that reach of Calapooia River downstream to about Brownsville.

3. Bacteria

Coliform bacterial objectives for recreation and water supply use are 1,000 MPN and 5,000 MPN, respectively. Municipal and industrial (sanitary) waste treatment, including disinfection, and controls at animal feed lots and grazing areas are required to reduce bacterial concentrations.

D. Evaluation of Flow Regulation Requirements

Maintenance of adequate minimum streamflows for control of water quality in Calapooia and Willamette Rivers will insure that economic values associated with water-oriented uses and activities will continue and have an opportunity to grow in the future without flow regulation. Waste treatment technology as now known and practiced will not in itself maintain water quality objectives in downstream areas of Willamette River and Portland harbor. With respect to Calapooia River quality, the 20 cfs base flow reserved by the Oregon Water Resources Board for stream conservation will adequately protect water quality over the projection period of this study.

1. Dissolved Oxygen (DO)

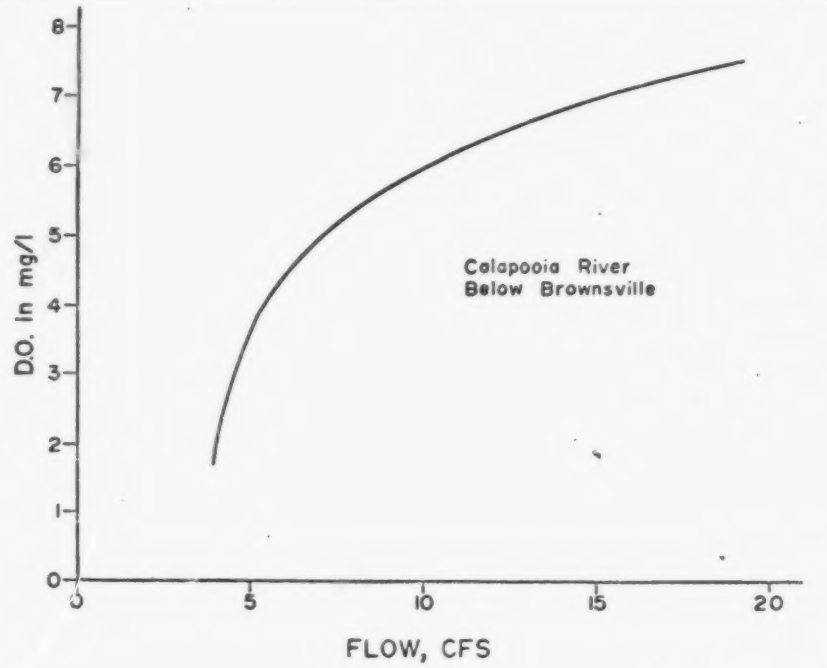
DO-flow relationships computed by use of oxygen balance techniques for present and projected waste loading conditions along Calapooia River and for Portland harbor are shown in Figure 6. A projected minimum need for 15 cfs in the Calapooia River at Brownsville and downstream during months of greatest loading (July-August--2010) is indicated. This flow compared with the flows for design one-in-ten year low monthly flow (46 cfs) (Table VIII-3), indicates that more than adequate streamflow (with adequate waste treatment) is available to meet Calapooia River dissolved oxygen objectives of 7 mg/l above Butte Creek and 5 mg/l below. According to this evaluation, therefore, a draft-on-storage (incremental increase over and above inflows) from Holley Reservoir for control of water

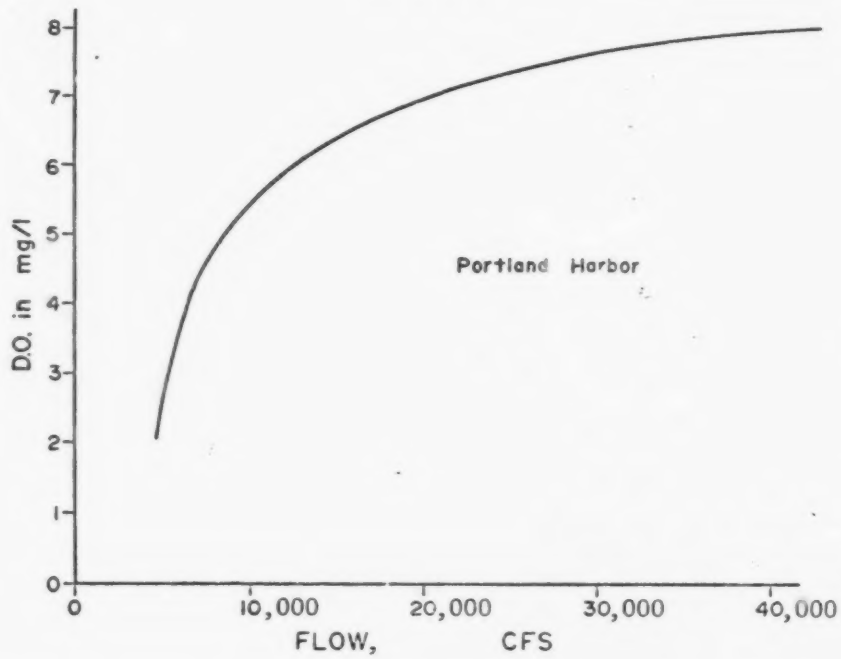
quality in Calapooia River does not appear needed during the study period.

Data shown in Table VIII-4 for Portland Harbor indicates that control of water quality in Portland harbor by the years 1985 and 2010 will require a total minimum average flow of 8,930 cfs and 9,280 cfs respectively during low flow periods (July through September) to assimilate treated wastes projected for those years. To obtain this flow and meet fish passage and other use objectives on a 90 percent annual achievement probability basis, an annual draft-on-storage of 623,000 acre-feet by 1985 and 690,000 acre-feet by the year 2010 will be needed. Without this regulation, adequate waste treatment to 85 percent by 1985 and to 90 percent efficiency by 2010 would control minimum DO levels to about 2 mg/l thus allowing little margin for diurnal fluctuations in waste loads, efficiency of plant operation, benthic demands, and effects of extreme drought. With the needed regulation indicated above, DO objective levels would not be significantly reduced on a one-in-twenty-year low flow recurrence interval.

2. Temperature

A preliminary study was undertaken on the Calapooia River to determine the probable thermal effects of the proposed Holley Reservoir. Possible reservoir release temperatures were determined using preliminary energy budget and water budget analyses. The maximum temperatures of proposed reservoir releases were determined at Brownsville, a point about 13 miles below the dam. In determining





Note:

Required Flows Are Based On Waste Treatment Efficiency Of 90% BOD Removal.

WATER SUPPLY & WATER QUALITY CONTROL STUDY
HOLLEY RESERVOIR PROJECT
CALAPOOIA RIVER BASIN, OREGON

DO-FLOW RELATIONSHIPS
YEAR 2010

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

REGION IX (DATE 12/66) PORTLAND, OREGON

Figure 6

TABLE VIII-3
REQUIRED STREAM FLOW REGIMEN FOR CONTROL OF DISSOLVED OXYGEN[1/]
CALAPOOIA RIVER BASIN, OREGON

Month	Design Low Base Flow[2/] (cfs)	Required Streamflow (cfs)
January	719	5
February	811	7
March	640	8
April	499	10
May	326	12
June	164	13
July	80	15
August	46	15
September	51	14
October	169	11
November	550	8
December	806	6

1/ Based on adequate treatment of organic wastes discharged to stream in year 2010.

2/ One-in-ten year low flow recurrence interval.

TABLE VIII-4
REQUIRED STREAMFLOW REGIMEN FOR WATER QUALITY CONTROL
WILLAMETTE RIVER AT PORTLAND, OREGON [1/]

Month	Base Flow (cfs)	Required Streamflow (cfs) 1985	Required Streamflow (cfs) 2010	Required Annual Draft-on-Stroage[2/] (acre-feet) 1985	Required Annual Draft-on-Stroage[2/] (acre-feet) 2010
January	36,240	4,810	4,924	0	0
February	34,090	4,790	4,902	0	0
March	26,970	5,050	5,223	0	0
April	22,020	5,671	5,854	0	0
May	17,800	7,395	7,614	0	0
June	10,390	7,942	8,182	0	0
July	5,260	9,418	9,615	255,800	268,000
August	4,760	9,312	9,572	280,000	296,000
September	6,590	8,061	8,643	87,500	126,300
October	9,660	6,770	7,003	0	0
November	24,780	5,316	5,553	0	0
December	32,490	4,386	4,571	0	0
Total, ac-ft				623,300	690,300

[1/] DO Objective: 5 mg/1 @ Portland harbor.

Treatment Level: 85% in 1985 and 90% in 2010. Applied uniformly to all M&I wastes throughout Willamette Basin.

Required Flow: Determined by computer analysis.

Temperatures: Cold releases from existing and possible reservoirs, and high monthly average temperatures downstream from Salem (assumed point of equilibrium).

Design Base Flow: Mean monthly one-in-ten year low flow at Portland adjusted for authorized regulation.

[2/] This is the additional quantity needed at Portland and does not include storage and transmission losses.

reservoir release temperatures, it was assumed that selector gates would be adopted. Results of the study are summarized in Table VIII-5.

TABLE VIII-5
REGULATION OF PROPOSED HOLLEY RESERVOIR
FOR DOWNSTREAM TEMPERATURE CONTROL
CALAPOOIA RIVER BASIN, OREGON

Month	Dam Site		Proposed Schedule Reservoir Releases		Probable Max. Stream Temp.@ Brownsville
	Natural Mean Monthly Disch. (cfs)	Mean Monthly Water Temp. (°F)	Release (cfs)	Est. Temp. (°F)	(°F)
May	375	52	321	50	55
June	190	58	483	60	65
July	75	66	658	60	70
August	40	66	556	60	70
Sept.	45	59	337	60	65
Oct.	195	50	132	55	60
Nov.	625	45	132	50	50

DATA SOURCE: U. S. Geological Survey and
U. S. Army Corps of Engineers

IX. BENEFITS

A. Water Supply - Municipal and Industrial (M&I)

As described in Chapter VII, a future need for storage for municipal and industrial supply exists in the Calapooia and adjacent Halsey area. The need by the end of the study period is for annual storage in Holley Reservoir (1,500 acre-feet) to yield the 1.3 mgd supplemental requirement or about 57 percent of the total expected demand (2.26 mgd). First need for about 500 acre-feet will begin approximately at the time of assumed project completion in 1975.

The value of storage for M&I water supply is considered equal to the cost of single-purpose development that would be incurred in obtaining the needed supply in the absence of Holley Reservoir Project. The most likely alternative storage sites available to serve the Brownsville-Halsey and the Holley areas are, respectively, on Cochran Creek about two and a half miles north of Brownsville, and on an unnamed tributary just north of Holley. Based on the total capital cost ($750,000) of these alternatives amortized over a 100-year period at 3.125 percent interest, the annual value of 1,500 acre-feet of storage in the project including annual operation and maintenance expenses ($3,900) is estimated to be $28,500.

B. Water Quality Control

Benefits can be assigned to releases from Federal storage for regulation of streamflow for water quality control only after a reasonable degree of treatment or control of waste at the source is

provided. In this instance, waste treatment or other controls at the source would not in itself meet the quality goals described in Chapter VIII.

Storage releases for control of water quality in Portland harbor and for enhanced stream temperatures in Calapooia River would produce economic benefits in terms of enhanced fish and wildlife production, improved recreational opportunities and public health, and aesthetic safeguards. The beneficiaries of this control are distributed widely throughout the Willamette River Basin, the State of Oregon, and the Pacific Northwest and cannot, therefore, be specifically identified. Riparian owners, a potential population of nearly 2 million persons, recreation, and fishery activities associated with anadromous fish runs (averaging more than 50,000 annually) would be the major recipients of the benefits of this control.

The precise monetary value of the benefit assignable to storage in Willamette Basin projects for water quality control is not in this instance readily measurable. The minimum value of the benefit assignable to an annual draft-on-storage in Holley Reservoir and/or additional reservoirs that may be required to meet water quality objectives in Portland harbor is, however, considered at least equal to the cost of achieving the same level of water quality by alternative means in the absence of the project or projects.

For purposes of this report, flow regulation benefits were analyzed on the basis of alternative single-purpose storage and advanced waste treatment costs. Waste disposal underground, holding

of waste for discharge during periods of high stream flow, waste transport downstream and restriction of future development were not considered to be either adequate or equivalent alternatives to the control that could be accomplished by flow regulation.

Compared to single-purpose storage (Plans A and B prepared by the U. S. Army Corps of Engineers) advanced waste treatment was found to be the cheapest alternative to flow regulation for water quality control. The estimated annual equivalent advanced waste treatment cost per acre-foot was found to be $3.98 compared to $9.90 for least-cost single-purpose storage.

Based on this alternative cost analysis, the minimum value of the widespread water quality control benefit assignable to storage for water quality control is $3.98 per acre-foot. Multiplied by 690,000 acre-feet--the total storage required by the year 2010--the annual benefit on a 100-year basis is $2,750,000 (rounded).

Specific storage releases from Holley Reservoir resulting in improved minimum flows in Portland harbor would have an annual worth of $3.98 per acre-foot. Water quality benefits associated with releases for temperature control and flow stabilization in Calapooia River would be at least equal to the value of the enhanced fishery. This latter value will be calculated by the U. S. Fish and Wildlife Service.

In planning for additional water resource development in Calapooia and Willamette River Basin areas, consideration should be given to preserving the excellent quality of water in upper basin

tributary streams and to maintaining sufficient quality in lower river areas to permit reasonable use for fish passage and rearing, recreation, and general aesthetic enjoyment. Maintenance of water quality objectives for fish migration and propagation would assure continued multiple use of the waters and would necessitate continued updating of waste treatment facilities, improved land and water management practices, and ultimate annual storage releases over and above present authorized development of 690,000 acre-feet for control of water quality in Portland harbor.

After the project is in operation, a system of water quality and waste monitoring and stream flow forecasting will be needed in order to fully utilize flow regulation for water quality control.

Maintenance of water quality in Calapooia River without flow regulation is predicated on the release of water which is relatively uniform in quality from Holley Reservoir. Thermal stratification and reduced dissolved oxygen in lower levels of the reservoir can be expected. Multi-gated outlets providing flexibility of releases by depth should, therefore, be considered in the design of Holley Dam.

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APPENDIX

APPENDIX

TABLE 1
RECORDED STREAMFLOW DATA
CALAPOOIA RIVER BASIN, OREGON

	HOLLEY	ALBANY
Station No.	14-1720	14-1735
Elevation, Ft.	527.58	180.85
Drainage Area, Sq. Mi.	105	372
Record	Sept 1935-Sept 1963	Oct 1940-Sept 1963
Average Discharge, cfs	448	930
Average Discharge, acre-feet	323,600	673,300
Maximum Day, cfs	12,200 Dec 28,'45	32,700 Dec 22,'55
Minimum Day, cfs	13 Sept 8,'40	4 Oct 7,'52
Regulation above Station	None	None
Diversions above Station	None	Approx 2700 acres irrigated

Source: U. S. Geological Survey - Water Supply Papers

TABLE 2
RECORDED STREAMFLOW DATA AT SALEM
WILLAMETTE RIVER BASIN, OREGON

Station Number	14-1910
Elevation, Feet	106.14
Drainage Area, Square Miles	7,280
Record	October 1909 - December 1916 January 1923 - September 1963
Average Discharge, cfs.	23,350
Average Discharge, Acre-Feet	16,900,000
Maximum Day, cfs.	500,000 Dec. 4, 1861
Minimum Day, cfs.	2,470 August 27, 1940
Regulation Above Station:	Since 1941 by Fern Ridge Reservoir Since 1942 by Cottage Grove Reservoir Since 1949 by Dorena Reservoir Since 1953 by Lookout Point and Detroit Reservoirs Since 1961 by Hills Creek Reservoir Since 1963 by Smith River Reservoir
Diversions Above Station:	Many small diversions for irrigation. Part of North Santiam River flow is diverted to Mill Creek and returns to river below station.

SOURCE: U. S. Geological Survey, Water Supply Papers

APPENDIX

TABLE 3
MEAN MONTHLY LOW FLOWS AT VARIOUS RECURRENCE FREQUENCIES
CALAPOOIA RIVER BASIN, OREGON
(cfs)

	HOLLEY[1]				BROWNSVILLE[2]			ALBANY[3]		
	RECURRENCE INTERVAL, YEARS				RECURRENCE INTERVAL, YEARS			RECURRENCE INTERVAL, YEARS		
MONTH	5	10	20	30	5	10	20	5	10	20
Jan.	620	519	438	400	862	719	610	1266	1080	932
Feb.	700	585	494	452	973	811	689	1345	1148	989
Mar.	553	461	390	356	768	640	544	945	806	695
Apr.	430	361	304	278	599	499	424	605	516	445
May	282	236	199	182	392	326	277	367	313	270
June	142	119	100	92	197	164	140	144	122	106
July	57	47	40	36	96	80	68	56	48	41
Aug.	32	26	22	20	55	46	39	26	22	19
Sept.	34	29	24	22	61	51	43	29	24	21
Oct.	146	122	104	94	203	169	144	158	135	116
Nov.	474	396	335	306	660	550	467	709	605	521
Dec.	696	581	491	449	968	806	685	1220	1040	897
Mean	347	290	245	224	486	405	344	680	580	500

1/ Natural Runoff
2/ Estimated -- Adjusted for Irrigation Diversions
3/ Not Adjusted for Diversions

TABLE 4
MEAN MONTHLY LOW FLOWS AT VARIOUS RECURRENCE FREQUENCIES
WILLAMETTE RIVER BASIN, OREGON
(cfs)

Month	SALEM Recurrence Interval, Years			PORTLAND HARBOR Recurrence Interval, Years		
	5	10	20	5	10	20
January	27,800	24,400	22,700	41,720	36,240	32,870
February	23,150	20,300	18,900	39,410	34,090	30,750
March	19,500	17,100	15,900	31,050	26,970	24,460
April	15,000	13,160	12,240	25,300	22,020	19,930
May	12,930	11,340	10,540	20,370	17,800	16,220
June	8,100	7,110	6,620	11,890	10,390	9,490
July	4,200	3,690	3,430	6,010	5,260	4,820
August	4,170	3,660	3,400	5,430	4,760	4,350
September	6,260	5,490	5,110	7,520	6,590	6,090
October	8,310	7,300	6,780	11,030	9,660	8,850
November	19,070	16,730	15,560	28,500	24,780	22,530
December	24,000	21,070	19,600	37,360	32,490	29,460
Mean	16,300	14,300	13,300	24,130	21,000	19,100

NOTE: These frequencies were developed from flow data adjusted for regulation by all Corps of Engineer storage projects now operating, under construction, or authorized for construction.

APPENDIX

TABLE 5
SURFACE WATER QUALITY AT ALBANY
CALAPOOIA RIVER BASIN, OREGON

Date	7/30/57	8/6/57	8/13/57	8/20/57	8/27/57	9/3/57	8/8/62	8/21/62	9/12/62
Time	-	-	-	-	-	-	0915	1000	0845
Analysis by	SSA	SSA	SSA	SSA	SSA	SSA	PHS	PHS	PHS
Temp. ^{o}F	71.5	68	70.5	70	-	70	64	68	60.5
pH	6.9	7.2	7.2	7.2	-	7.3	7.6	7.7	7.5
DO, mg/l	8.4	8.4	8.5	7.8	8.9	8.5	8.8	8.1	8.8
% Sat.	95	92	95	87	-	95	92	89	89
BOD_5, mg/l	0.7	0.4	0.4	0.3	1.0	0.1	0.5	0.7	0.6
MPN	2400	2300	620	2400	620	2400	4100	2900	1030
Fecal Coli	-	-		-	-	-	500	500	100
Strep MF	-	-	-	-	-	-	96	280	140
Flow, cfs	59	56	60	43	30	21	70	40	42

Note: SSA - Oregon State Sanitary Authority
PHS - U. S. Public Health Service

TABLE 6

MINERAL CONTENT OF MUNICIPAL WATER SUPPLIES
LINN COUNTY, OREGON

Analysis	Brownsville 3-16-1961 Parts Per Million	Halsey 6-15-1961 Parts Per Million
Color	2.0	1.0
Turbidity	51.0 a/	4.0
pH	7.10	6.80
Alkalinity Bicarbonate	54.0	164.0
Carbon Dioxide	9.0	45.0
Aluminum	0.12	<0.05
Ammonia Nitrogen	0.31	0.16
Calcium	12.3	160.0
Chloride	11.3	423.0
Fluoride	<0.1	0.1
Hardness	55.4	730.0
Iron	0.68	<0.05
Magnesium	6.0	84.5
Manganese	0.10	0.35
Phosphates	<0.01	0.28
Potassium	0.3	3.9
Silicon	13.0	45.5
Sodium	6.2	104.0
Sulfates	5.6	1.8
Total Solids	134.0	1210.0
Volatile Solids	26.0	338.0
Nitrates	0.20	2.7
Nitrites	0.048	0.007
Conductance (mc mho/cm)	104.0	1700.0

a/ sample highly turbid due to heavy red precipitate indicating iron-manganese oxide

Source: Oregon State Board of Health

APPENDIX

TABLE 7
SURFACE WATER QUALITY
WILLAMETTE RIVER MAINSTEM, OREGON
(milligrams per liter)

Location & Date	Flow at Salem (cfs)	Temp.	Sulfate	Chloride	Nitrate	Dissolved Solids	Hardness ($CaCO_3$)	Alkalinity as $CaCO_3$	Specific Conduct. a/	pH	Source b/
ALBANY											
8/17/65	--	71.5	0.5	2	0.24	96	24	22	69	7.1	OSSA
SALEM											
10/1-10/61	7,081	59	3.0	3.5	0.5	55	22	--	67	7.0	USGS
1/1-15/62	39,050	45	3.2	2.0	0.7	51	17	--	52	6.9	USGS
4/6-15/62	38,650	50	2.8	1.5	0.6	53	15	--	46	6.7	USGS
7/1-14/62	7,255	65	3.6	2.5	0.6	51	22	--	63	7.2	USGS
8/17/65	--	--	1	3	0.3	63	26	19		---	OSSA
NEWBERG											
8/17/65	--	70	2	5	0.45	74	22	24	82	7.0	OSSA
OREGON CITY (above Willamette Falls)											
11/29/60	75,900	45.5	9	3	0.09	131	17	15	46	6.8	OSSA
8/17/65	--	69	1	3	0.47	78	29	19	76	6.9	OSSA
PORTLAND HARBOR											
11/29/60	75,900	44.5	---	---	---	--	--	--	46	6.8	OSSA
11/27/60	24,700	43	2	4	0.31	64	22	23	52	6.9	OSSA
9/7/62	5,900	67.5	7	6	---	80	52	32	--	6.8	PHS*
9/4/63	6,220	69	7	13	---	75	38	30	--	---	PHS*
8/26/64	6,700	70.5	6	3	---	51	28	26	66	6.6	PHS*
8/17/65	4,900	68	2	5	0.47	72	31	18	98	6.6	OSSA

a/ micromhos per centimeter
b/ SOURCE: U.S.Geological Survey (USGS); Oregon State Sanitary Authority (OSSA); Public Health Service (PHS).
* Note: Effective 1/1/66 PHS organization's name changed to Federal Water Pollution Control Adm. (FWPCA).

TABLE 8
GROUND WATER QUALITY AT ALBANY
CALAPOOIA RIVER BASIN, OREGON

	Well #490	Well #494-498
Depth, Ft.	295	41
Date of Sample	10-12-28	10-12-28
Temperature ^{o}F	54	-
TDS, ppm	4967	116
Silica (siO_2) ppm	15	38
Iron (Fe) ppm	1.03	0.05
Calcium (Ca) ppm	324	12
Magnesium (Mg) ppm	62	6.9
Sodium (Na) ppm	1450	5.7
Potassium (K) ppm	14	1.6
Bicarbonate (HCO_3) ppm	100	71
Sulphate (SO_4) ppm	1.9	4.4
Chloride (Cl) ppm	2956	2.4
Nitrate (No_3) ppm	0.0	6.7
Total Hardness as Ca CO_3, ppm	1064	58
Percent Sodium	74.9	19.8

Well #490: Albany, 5½ miles S.W. of; at about river mile 10 on Calapooia River.

Well #494-498: Albany, 3 miles N.E. of; north of Calapooia Basin and about 2 miles west of Willamette River.

Source: U. S. Geological Survey, WSP 890

TABLE 9

INVENTORY OF MAJOR WASTE SOURCES
WILLAMETTE RIVER BASIN, OREGON

Contributing Community or Industry	River Mile	Pop. Served	Untreated Waste PE	Treatment	Capacity Design PE	Const. Date	Discharged Waste PE	Project Needs	Status of Improvement
Coast Fork	187								
Cottage Grove	21	4,200	4,200	Primary	6,000	1953	2,750	Secondary	Preliminary plan
Coast Slough	9								
Creswell	5	800	800	Lagoon	1,000	1962	160	None	-
Middle Fork	187								
Lowell	41	2,100	2,100	Primary	2,000	1952	1,400	Secondary	Preliminary plan
Lowell	18	550	550	Secondary	3,200	1949	110	None	-
Springfield	184	21,700	36,700	Secondary	40,000	1962	7,650	None	-
Eugene	178	55,000	205,800	Secondary	165,000	1961	72,300	Enlarge	Under construction
McKenzie River	174								
Weyerhaeuser Co.	9	-	112,000	Lagoon	-	-	27,130	Addition	Preliminary plan
Junction City	164	1,800	7,800	Primary	5,000	1949	3,800	Secondary	Preliminary plan
Harrisburg	161	900	1,200	Primary	1,000	1957	780	Secondary	Preliminary plan
Long Tom River	146								
Monroe	11	350	350	None	-	-	350	Secondary	Final plan
Marys River	132								
Philomath	10	1,300	1,300	Secondary	1,800	1952	200	None	-
Corvallis	131	22,000	120,000	Primary	28,000	1954	84,000	Secondary	Under construction
Evans Products		-	9,000	None	-	-	9,000	New plant	None
Bowers Slough	123								
Adair Air Force Base	4	700	700	Secondary	750	1959	100	None	-
California River	120								
Brownsville	33	600	600	Lagoon	1,000	1964	120	None	-
Albany	119	14,000	80,000	Secondary	32,000	1954	49,000	Enlarge	Final Plan
Western Kraft			114,000	In-plant cont.	-	-	63,200	Addition	Preliminary plan
Santiam River	109								
South Santiam	12								
Crest Hope	32	3,500	3,600	Secondary	3,500	1948	720	Enlarge	Final Plan
Lebanon	17	6,400	7,500	Secondary	10,000	1958	2,400	None	-
U. S. Plywood		-	7,000	Lagoon	-	-	2,400	None	-
Crown Zellerbach	15	-	525,000	Recovery	-	-	56,400	Addition	Preliminary plan
North Santiam	12								
Stayton	28	2,000	2,000	Secondary	3,500	1964	400	None	-
Stayton Canning Co.		-	70,000	Land	-	-	0	None	-
Paris Woolen Mills		-	4,800	Land	-	-	0	None	-
Jefferson Woolen Mills	9	-	4,200	Lagoon	-	-	840	None	-
Independence	96	4,500	4,800	Primary	6,000	1951	3,500	Secondar,	Final plan

TABLE 9 (Cont.)

INVENTORY OF MAJOR WASTE SOURCES
WILLAMETTE RIVER BASIN, OREGON

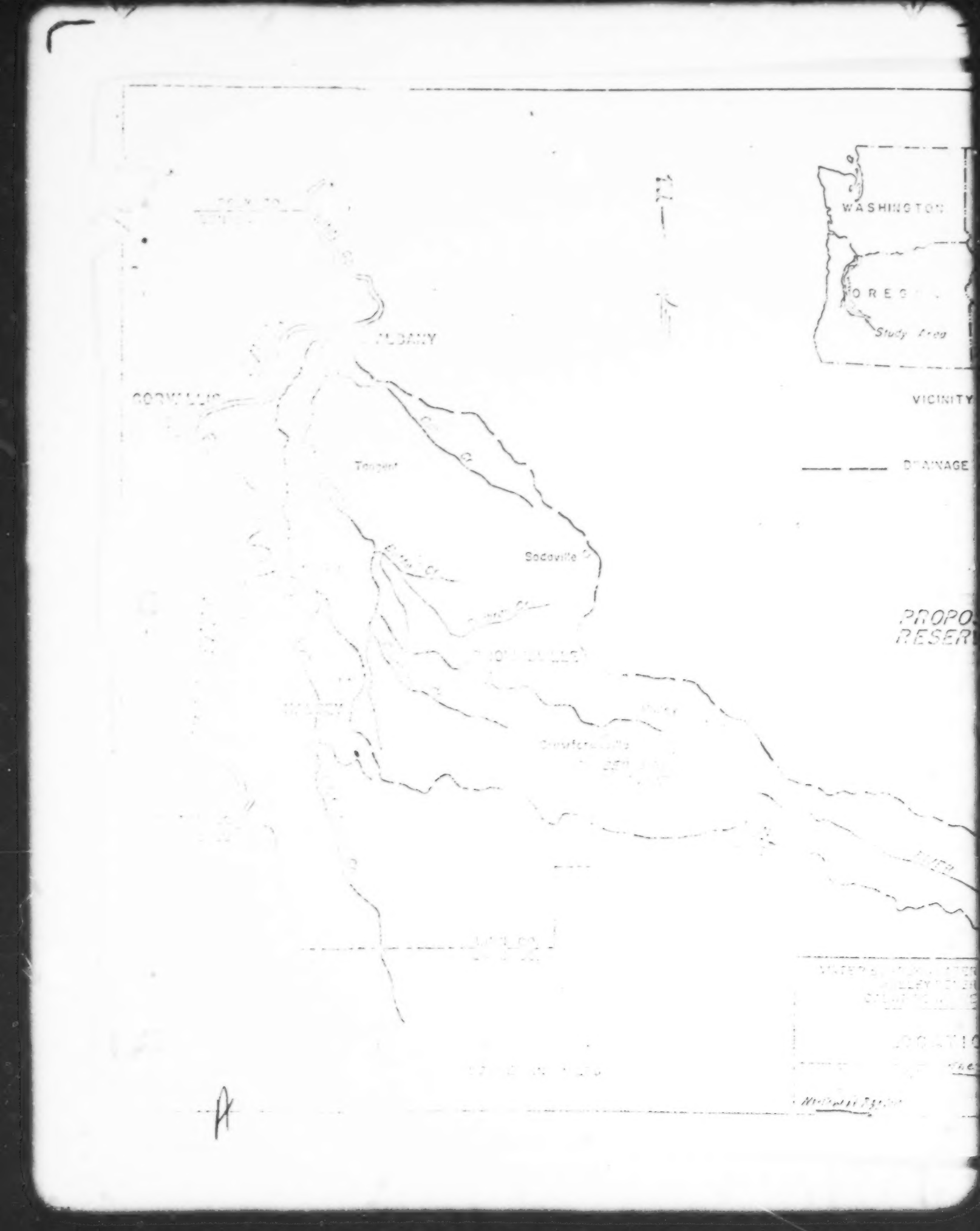
Watercourse Community or Industry	River Mile	Pop. Served	Untreated Waste Lb	Treatment	Capacity Lbs/Day BOD	Const. Date	Discharged Waste Lb	Project Needs	Status of Improvement
Ash Creek	95								
Klamath	1	2,000	2,000	Lagoon	8,000	1963	400	None	-
Pudding Creek	88								
Salem	12	5,400	8,400	Secondary	8,000	1952	1,260	Enlarge	Preliminary plan
Boise Cascade Corp.	80	60,000	390,000	Secondary	455,000	1964	58,500	None	-
Lake Labish Ditch	78	-	826,000	Holding pond	-	-	30,000	Addition	Preliminary plan
Confederated Indian Agency	6	900	900	Lagoon	1,500	1965	60	None	-
Aldercrest Farms #1	67	-	7,500	Land	-	-	0	None	-
Yamhill River	55								
South Yamhill River	17								
Dayton	17	1,700	1,700	Secondary	2,500	1962	560	None	-
McMinnville	5	8,000	12,800	Secondary	8,000	1953	2,080	Enlarge	Final plan
North Yamhill River	11								
Yamhill Inter Camp	5	1,000	1,000	Secondary	1,000	1941	120	Replace	Under construction
Carlton	5	1,000	1,000	Secondary	1,000	1955	200	None	-
Lafayette	8	500	500	Lagoon	875	1964	100	None	-
Aldercrest Farms #2	5	-	6,000	Lagoon	-	-	0	None	-
Newberg	50	4,000	4,000	Secondary	8,000	1963	930	None	-
Publishers Paper Co.	40	-	774,000	Holding pond	-	-	373,000	Addition	Preliminary plan
Corral Creek	1	1,000	1,000	Secondary	2,330	1963	150	None	-
Veterans Hospital	36								
Mobile Home Park	1								
Rock Creek	49								
St. Vincent	3	3,600	20,000	Secondary	28,000	1963	3,000	None	-
Mt. Angel	34	1,200	6,200	Secondary	5,000	1955	930	Enlarge	No plans
Beer Creek	16								
Molalla	10	1,400	1,400	Secondary	3,000	1955	210	None	-
Mill Creek	7								
Woodburn	9	4,000	5,400	Secondary	9,500	1964	810	None	-
General Foods		-	42,000	Land	-	-	0	None	-
Canby	34	2,000	2,400	Secondary	2,000	1963	360	None	-
Tualatin River	29								
Forest Grove	55	6,000	61,000	Secondary	90,000	1965	4,200	None	-
Forest Fibre Products		-	78,000	Land	-	-	0	Impr. Oper.	None

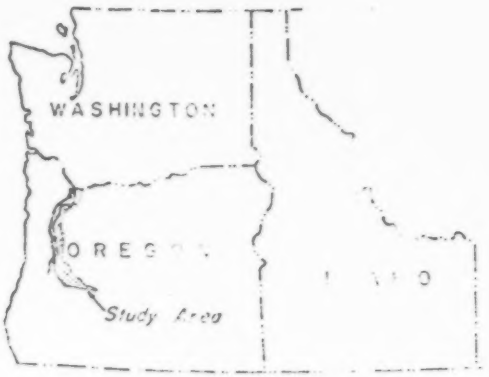
TABLE 9 (Cont.)

INVENTORY OF MAJOR WASTE SOURCES
WILLAMETTE RIVER BASIN, OREGON

Watercourse Community or Industry	River Mile	Pop. Served	Untreated Waste PE	Treatment	Capacity Design PE	Const. Date	Discharged Waste PE	Project Needs	Status of Improvement
Tualatin River (Cont.)	29								
Cornelius	50	1,000	1,200	Secondary	2,500	1959	150	None	-
Hillsboro #1	44	5,000	9,000	Secondary	5,000	1936	2,100	Replace	Preliminary plan
Rock Creek	38								
Scenset West	6	640	800	Secondary	1,600	1964	120	None	-
Beaverton Creek	5								
Cedar Hills	7	7,600	9,300	Secondary	13,000	1962	1,400	None	-
Beaverton	6	9,500	14,500	Secondary	14,000	1963	2,300	None	-
Tektronix, Inc.	5	1,500	1,800	Secondary	4,000	1963	270	None	-
Cedar Mill Creek	4								
Sunset Valley S.D.	3	4,800	7,400	Secondary	10,000	1965	1,255	None	-
Aloha S.D.	1	6,350	8,000	Secondary	12,000	1965	1,000	None	-
Hillsboro #2	1	4,500	6,000	Secondary	10,000	1959	1,200	None	-
Chicken Creek	16								
Cedar Creek	3								
Shute's	1	700	6,600	Secondary	5,500	1965	1,800	None	-
Fanno Creek	9								
Fanno Creek S.D.	7	16,000	16,200	Secondary	15,000	1961	2,550	Enlarge	Preliminary plan
Tualatin Hills	5	1,200	1,200	Secondary	1,400	1962	180	None	-
Tigard	3	2,300	6,000	Secondary	5,600	1965	600	None	-
West Linn #2	25	1,500	1,500	Secondary	2,500	1963	330	None	-
Crown Zellerbach	26	-	1,172,000	Holding pond	-	-	342,400	Addition	Preliminary plan
Pottlehara Paper Co.	26	-	882,000	Barging	-	-	172,700	Addition	Preliminary plan
Oregon City	25	12,000	21,000	Secondary	56,000	1964	3,150	None	-
Clackamas River	25								
Estacada	23	1,000	1,000	Secondary	2,500	1963	150	None	-
Tickle Creek	15								
Sandy	10	1,200	1,200	Secondary	1,500	1955	180	None	-
West Linn #1	24	3,000	3,000	Secondary	7,000	1963	450	None	-
Marylhurst	22	600	600	Secondary	1,100	1962	200	None	-
Oakledge	21	13,000	13,000	Secondary	12,000	1961	1,900	None	-
Tryon Creek	21	8,000	10,000	Secondary	31,000	1965	1,100	None	-
Milwaukie	18	10,000	10,000	Secondary	14,000	1962	1,500	None	-
Portland	-	370,000	365,000	Tertiary	500,000	1962	(260,000)*	None	-
Portland Waterfront	-	-	128,000	None	-	-	128,000	Intercept	Preliminary plan

* To Columbia River


WASHINGTON
Study Area
VICINITY
DRAINAGE
Tangent
Sodaville
PROPO
RESER



VICINITY MAP

DRAINAGE BASIN BOUNDARY

PROPOSED RESERVOIR

A-12 — B